UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF NEW YORK

O2Cure Ltd. *Plaintiff,* v. **CVD Equipment Corporation** *Defendant.*	Civil Action No. 19-cv-6470 Jury Trial Demanded

COMPLAINT

Plaintiff O2Cure Ltd. ("**O2Cure**"), as and for its Complaint against Defendant CVD Equipment Corporation ("**CVD**" or "**Defendant**"), alleges the following:

NATURE OF THE ACTION

1. This is an action for patent infringement of United States Patent Nos. 9,138,522 (the "**'522 Patent**") and 9,827,534 (the "**'534 Patent**) (together, the "**Asserted Patents**").

THE PARTIES

2. Plaintiff O2Cure is a company organized and existing under the laws of Israel. Its principal place of business is located at 5 Nahum Het Street, Haifa, 3508504, Israel.

3. Defendant CVD is a corporation organized and existing under the laws of the State of New York, with a principal place of business at 355 South Technology Drive, Central Islip, NY 11722. CVD designs, manufactures, and sells chemical vapor deposition systems and fluid delivery systems. "CVD" is the abbreviation for chemical vapor deposition.

JURISDICTION AND VENUE

4. This is an action for patent infringement, under the patent laws of the United States, 35 U.S.C. § 271 et seq. This Court has subject matter jurisdiction over O2Cure's claims pursuant to 28 U.S.C. §§ 1331 and 1338(a).

5. This Court has personal jurisdiction over CVD at least because CVD resides in this judicial district and has committed and continues to commit acts of direct and indirect patent infringement in this judicial district.

6. Venue is proper in this Court pursuant to 28 U.S.C. § 1400(b). CVD is incorporated in the State of New York, and resides in this judicial district. CVD has also committed and continues to commit infringing acts in this judicial district and has a regular and established place of business in this judicial district.

PATENTS-IN-SUIT

7. U.S. Patent No. 9,138,522, titled "Gas Exchanger and Artificial Lung," was duly and legally issued on September 22, 2015 by the United States Patent and Trademark Office to Dr. Yoram Palti. O2Cure is the sole owner by assignment of all right, title and interest in and to the '522 Patent, including the right to sue and recover for any and all infringement thereof, including past infringement. A true and correct copy of the '522 Patent is attached hereto as Exhibit 1.

8. U.S. Patent No. 9,827,534, titled "Gas Exchanger and Artificial Lung," was duly and legally issued on November 28, 2017 by the United States Patent and Trademark Office to Dr. Yoram Palti. The '534 Patent is a continuation-in-part of the '522 Patent. O2Cure is the sole owner by assignment of all right, title and interest in and to the '534 Patent, including the right to

sue and recover for any and all infringement thereof, including past infringement. A true and correct copy of the ’534 Patent is attached hereto as Exhibit 2.

9. The Asserted Patents are valid and enforceable.

10. The Asserted Patents relate to carbon nanotube gas exchange structures that incorporate multiple fluid channels defined by the arrangement of nanotubes. The structures are designed for use in artificial lung systems used to replace or supplement the capability of a patient’s own lungs to transfer oxygen (O_2) into, and remove carbon dioxide (CO_2) out of, the patient’s own blood. An annotated figure from the ‘522 Patent is provided below.

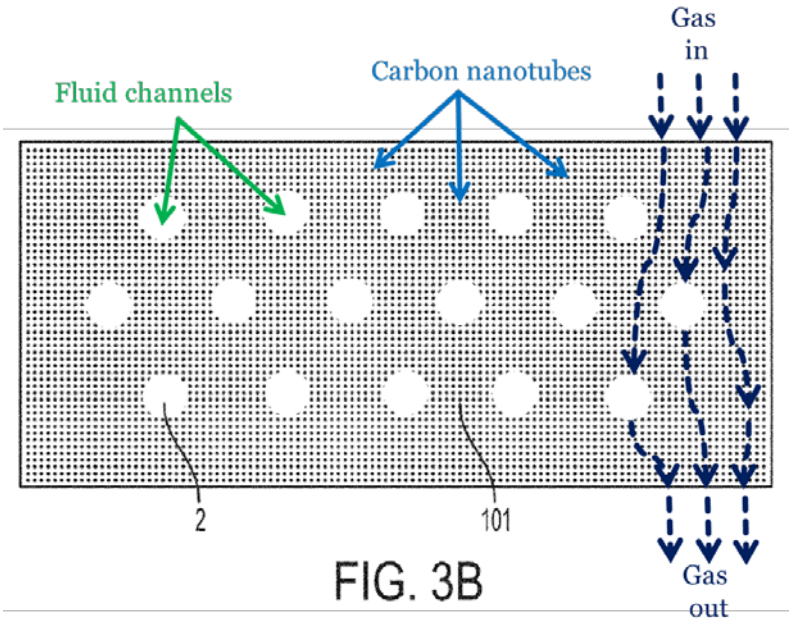
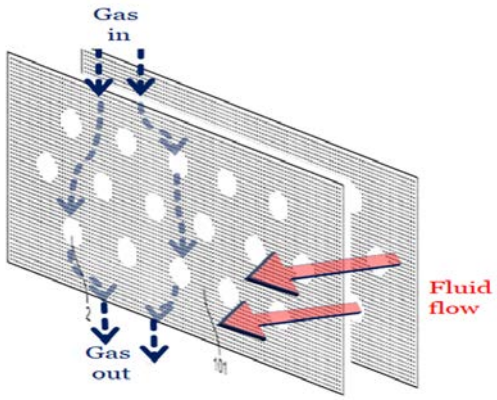


FIG. 3B

’522 Patent, Figure 3B (annotated). Extending the figure from the ‘522 Patent into three dimensions yields:



(Based on '522 Patent, Figure 3B and annotated).

11. By spacing the nanotubes close enough together, liquid blood can be pumped through, and substantially retained within, the fluid channels. While blood is flowing through the fluid channels, oxygen gas can be pumped, in a direction generally perpendicular to the blood flow, through the spaces between the nanotubes surrounding those fluid channels. Oxygen flowing through the spaces reach the fluid channels to oxygenate the blood and displace carbon dioxide gas. The carbon dioxide gas flows through the spaces and out of the structure.

12. O2Cure is using the patented technology in the Asserted Patents to develop blood oxygenation devices that will be superior to traditional extracorporeal membrane oxygenation (ECMO) devices for treating patients with respiratory conditions.

CVD'S INFRINGING TECHNOLOGY

13. O2Cure and CVD entered into a business relationship pursuant to which CVD manufactured for O2Cure carbon nanotube structures having fluid channels, according to technical specifications provided by O2Cure. The relationship between O2Cure and CVD was governed by certain agreements between them, including confidentiality agreements. Without authorization from O2Cure, CVD has been making, using, advertising, and offering to sell

devices incorporating carbon nanotube structures and implementing O2Cure's patented technology.

14. CVD manufactures free-standing, vertically aligned carbon nanotube structures that it refers to as "c-VACNT™" materials. "VACNT" is the abbreviation for vertically-aligned carbon nanotube. After CVD adds additional carbon to a VACNT structure, it refers to the resulting structure as "c-VACNT." On information and belief, CVD's c-VACNT structures are substantially similar to the carbon nanotube structures it previously manufactured for O2Cure in accordance with O2Cure's technical specifications.

15. As described in CVD's publication "c-VACNT™, New Nano-to-Macro Material Platform with a Rich Application Potential" (attached hereto as Exhibit 3), CVD promotes the use of its c-VACNT materials to "improve the performance of medical and industrial devices, including extracorporeal membrane oxygenators (ECMOs) and artificial lungs." Exhibit 3, p. 1.

16. CVD forms "reactor core elements" (RCEs) with the c-VACNT material. The RCEs are "used to build three or four port fluid reactors [1,2] that compositionally change at least one primary input fluid into a primary output fluid with the aid of one secondary fluid or one secondary input and output fluid. Typically, the primary fluids are liquids, and the secondary fluid (or fluids) is (are) either a gas or liquid." Exhibit 3, p. 5. In other words, CVD uses its carbon nanotube RCEs to facilitate interaction between a liquid and a gas.

17. CVD's RCEs contain fluid channels surrounded by the carbon nanotubes, as shown in the magnified views of an RCE below:

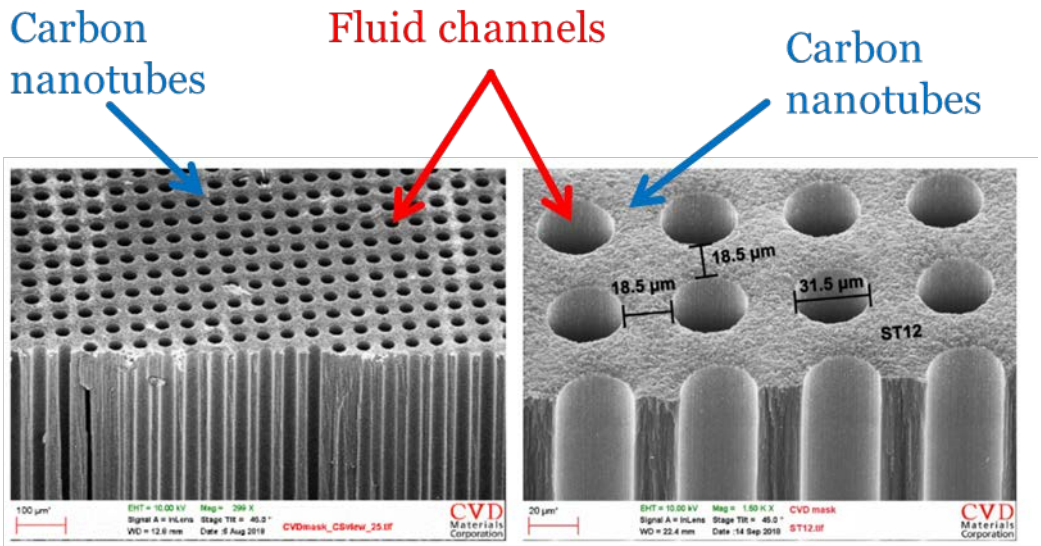


Figure 7: c-VACNT™-RCE with a non-tortuous flow path

Exhibit 3, Figure 7 (annotated).

18. CVD's publication provides a magnified view of the closely spaced carbon nanotubes in the cVACNT material:

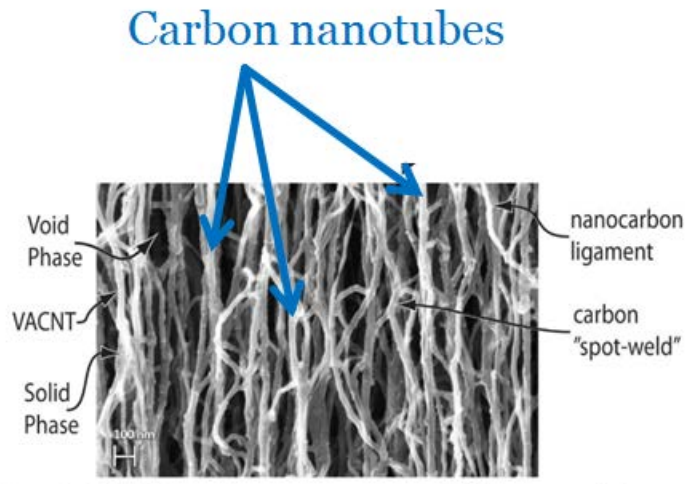


Figure 2: c-VACNT™ material tortuous nanostructure using VACNT's as nanocarbon ligaments

Exhibit 3, Figure 2 (annotated).

19. CVD explains that "the primary fluids travel through the c-VACNT – RCE" via the fluid channels and a secondary fluid travels "through the porous c- VACNT™ material between fluid channel sidewalls and the exterior sides of respective c- VACNT™ -RCE and a respective secondary fluid entrance or exit port." Exhibit 3, p. 6.

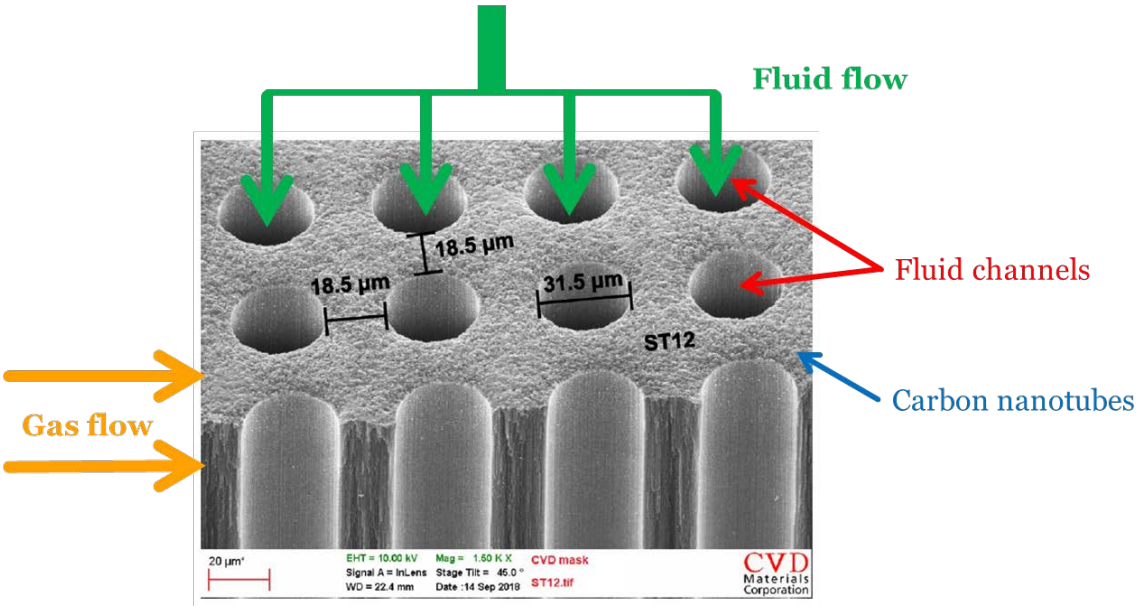


Exhibit 3, Figure 7 (annotated). Within the c-VACNT RCE, the primary input fluid (e.g., liquid) and the secondary input fluid (e.g., gas) interact within the fluid channels to change the primary input fluid into a primary output fluid and to change the secondary input fluid into a secondary output fluid. Exhibit 3, pp. 5-8.

20. CVD has manufactured and tested a range of RCEs having defined "fluid channel areas" in the carbon nanotube structures as shown below.

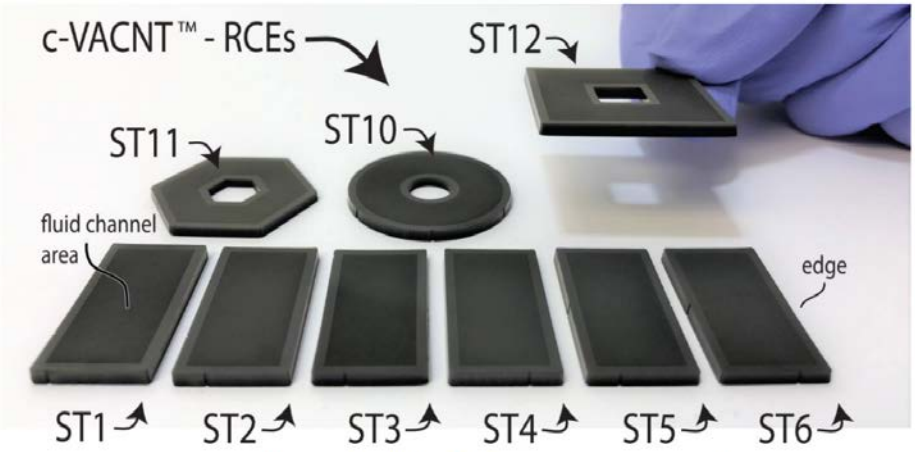


Figure 5: A range of c-VACNT™ - structure types (Table1)

Exhibit 3, Figure 5.

21. CVD tested carbon nanotube RCEs in "ECMO prototype devices" using water as the primary fluid passed through the fluid channels and using oxygen (O_2) gas and air as the secondary fluid passed through the spaces between the carbon nanotubes. Exhibit 3, p. 8. In those tests, CVD monitored the "change in oxygenation and de-oxygenation rate over time" caused by interacting the water in the fluid channels with the oxygen and air. Exhibit 3, p. 8.

22. In a presentation titled "Air Powered Artificial Lung and other High Efficiency Fluid Reactor Innovations," attached as Exhibit 4 and available on CVD's website at https://www.cvdequipment.com/2019/09/04/air-powered-artificial-lung-and-other-high-efficiency-fluid-reactor-innovations/, CVD stated that it plans to "explore blood compatibility of c-VACNT – ECMOs." Exhibit 4, p. 15. CVD's publication identifies planned "c-VACNT – ECMO" products using the RCEs and suggesting they will be tested with blood:

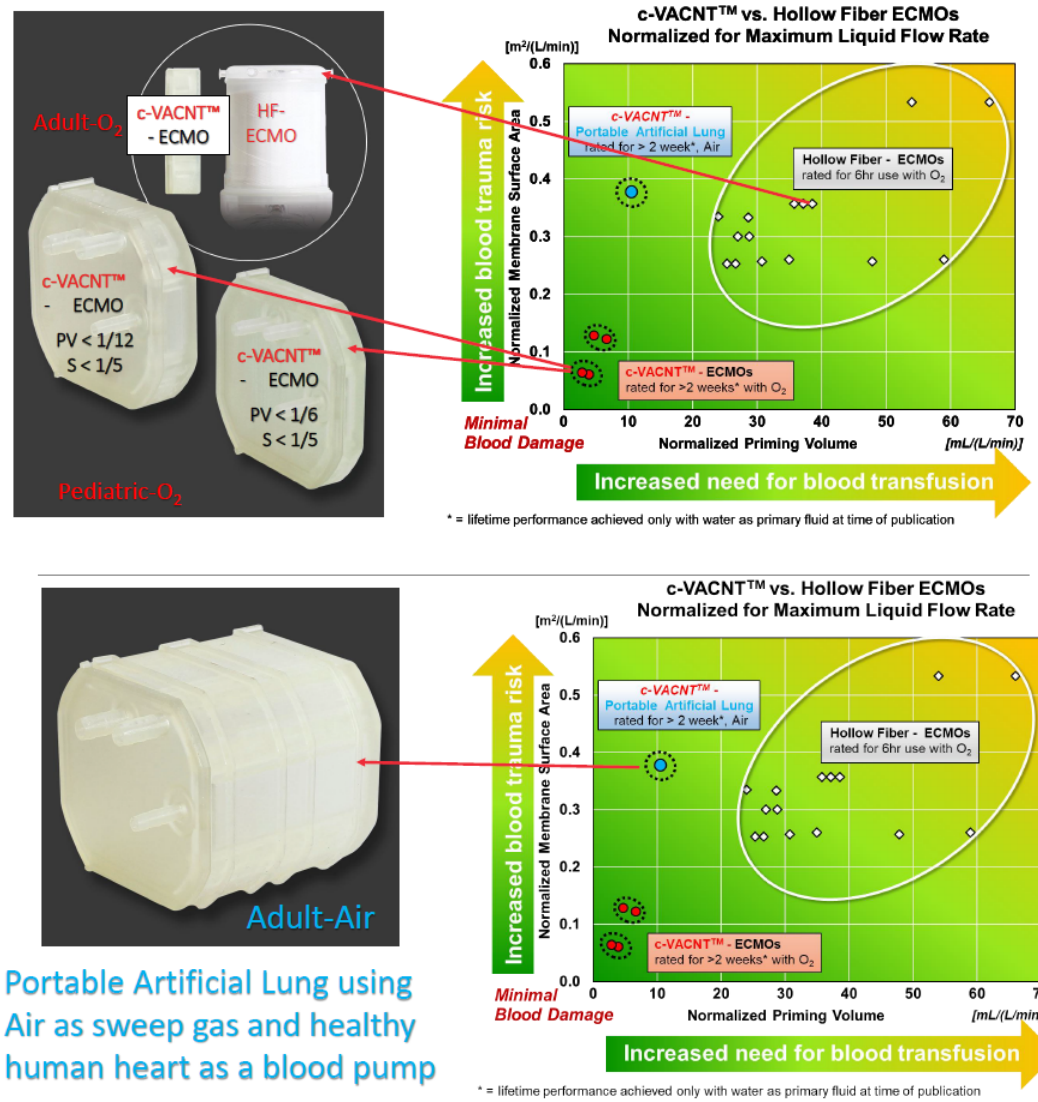


Exhibit 4, pp. 10-11. An identically titled article "Air Powered Artificial Lung and other High Efficiency Fluid Reactor Innovations" is attached as Exhibit 6 and available on CVD's website at https://www.cvdequipment.com/2019/06/12/air-powered-artificial-lungs-and-other-high-efficiency-fluid-reactor-innovations/.

23. CVD recently demonstrated and marketed VACNT RCEs, including for use in ECMO devices, at the 2019 TechConnect World Innovation Conference and Expo in Boston, MA on June 18, 2019. The screen captures below (and attached hereto as Exhibit 5) are from Defendant's Twitter feed, available at

https://twitter.com/cvdequipment355/status/1141025263263854594, where CVD posted pictures of its presentation booth at the conference:

Exhibit 5.

24. On information and belief, CVD is collaborating with at least one university in this district to continue the development and testing of its c-VACNT – RCEs in ECMO devices with blood.

COUNT I

Infringement of the ’522 Patent

25. O2Cure incorporates by reference each and every allegation contained in Paragraphs 1 through 24 above, as though set forth herein in their entirety.

26. CVD has directly infringed and, on information and belief, continues to directly infringe, one or more claims of the ’522 Patent, including exemplary claim 27, in violation of 35 U.S.C. § 271(a) by making, using, offering to sell, and selling in this judicial district and elsewhere, fluid reactor and ECMO devices that include Defendant’s c-VACNT™ RCEs.

27. Exemplary claim 27 of the ’522 Patent recites:

> A method for interacting a fluid with a gas, the method comprising the steps of:
> providing a plurality of fluid flow channels that are surrounded by nanotubes, each of the channels having an inflow end and an outflow end, wherein each of the channels is wide enough for a fluid to flow through, and wherein the nanotubes are spaced close enough to each other to retain the fluid within the channels when the fluid is flowing through the channels;
> passing fluid [. . .] through the channels; and
> passing a gas through the spaces between the nanotubes outside the fluid flow channels,
> wherein the gas interacts with the fluid in the channels.

28. CVD practiced the claimed “method for interacting a fluid a gas” as described in Exhibit 3. CVD tested its RCEs in “ECMO prototype devices” with “water as the primary fluid” interacting with “both O_2 or air as the sweep-gas.” Exhibit 3, p. 8.

29. CVD provided at least one c-VACNT RCE containing “a plurality of fluid flow channels that are surrounded by nanotubes” as illustrated in Figure 7 of Exhibit 3:

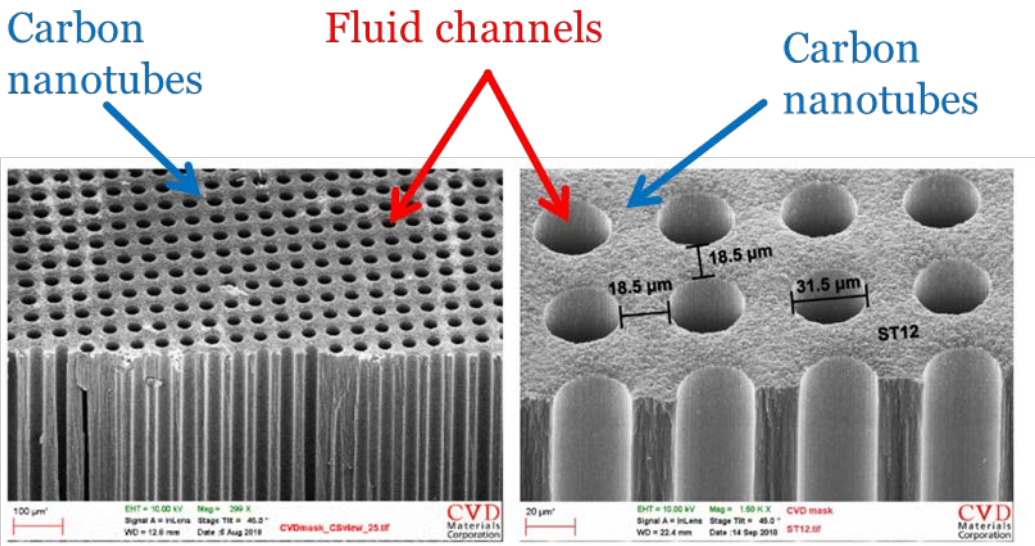


Figure 7: c-VACNT™-RCE with a non-tortuous flow path

Exhibit 3, Figure 7 (annotated).

30. Each of the fluid channels has an "inflow end and an outflow end" through which the primary input fluid "travels through." Exhibit 3, pp. 5-7.

31. Each of the fluid channels in the c-VACNT RCEs "is wide enough for a fluid to flow through." As CVD explained, it tested ECMO devices incorporating the c-VACNT RCEs by flowing water through the fluid channels from an input port to an output port. Exhibit 3, pp. 5-9, Figure 8.

32. The c-VACNT carbon nanotubes surrounding the fluid channels in the RCEs are "spaced close enough to each other to retain the fluid within the channels when the fluid is flowing through the channels." The "porous c-VACNT material" that forms the sidewalls of the fluid channels "effectively functions as a membrane with an asymmetric transmission that spatially isolates the primary and secondary fluid pathways." Exhibit 3, p. 6. The fluid channels form the primary fluid pathways "through which the primary fluids travel" and the spaces within the "porous c-VACNT material" form the secondary fluid pathways through which the secondary fluid travels. Exhibit 3, p. 6.

33. CVD tested "ECMO prototype devices incorporating superhydrophobic c-VACNT™ - RCE samples" with "water as the primary fluid" traveling through the fluid channels and oxygen or air as the "test sweep gas." Exhibit 3, pp. 7-8. In separate tests, gaseous oxygen and air were passed "through the spaces between the nanotubes outside the fluid flow channels" as claimed. On information and belief, the test system used by CVD is shown below:

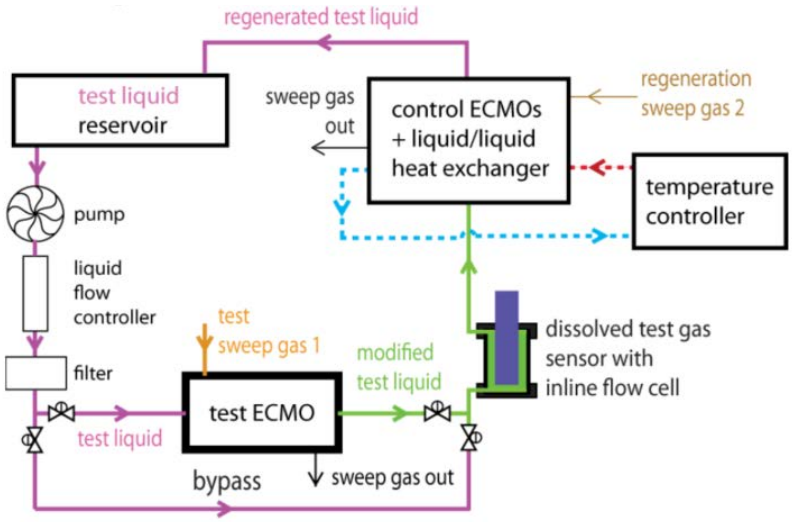


Figure 2: Non-destructive test setup for ECMO devices

Exhibit 6, Figure 2.

34. CVD graphed its test results using (a) water and oxygen and (b) water and air in Figure 8 of Exhibit 3:

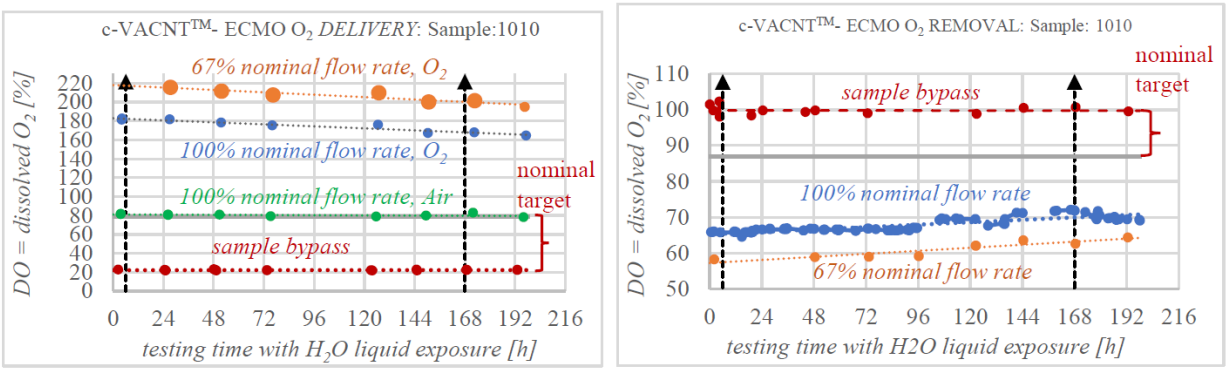


Figure 8: Oxidation/de-oxygenation rate test for hydrophobic c-VACNT™ - ECMO prototypes

Exhibit 3, Figure 8.

35. CVD specifically tested whether "the gas interacts with the fluid in the channels" and determined how much oxygen became dissolved in the test water. CVD observed the interaction of the gaseous oxygen and air with the water in the fluid channels by "monitoring the change in oxygenation and de-oxygenation over time." Exhibit 3, p. 8 and Figure 8.

36. On information and belief, CVD has and is actively, knowingly, and intentionally inducing infringement of the '522 Patent by research partners, customers, and other third parties in violation of 35 U.S.C. § 271(b). CVD has had knowledge of the '522 Patent at least as of the service of this Complaint, and has been aware that directing its customers or research partners to use the c-VACNT RCEs in an ECMO device infringes at least exemplary claim 27 of the '522 Patent.

37. On information and belief, CVD has induced, and is currently inducing, at least one university to directly infringe the '522 Patent by testing ECMO devices incorporating CVD's c-VACNT RCEs with blood and oxygen or air. On information and belief, CVD is paying the university to conduct such testing.

38. CVD's infringement has been without permission, consent, authorization, or license from O2Cure.

39. By reason of CVD's infringing activity, O2Cure has suffered, and will continue to suffer, substantial damages in an amount to be determined at trial.

40. CVD's infringing acts complained of herein have damaged and will continue to damage O2Cure irreparably. O2Cure has no adequate remedy at law for these wrongs and injuries, and is therefore entitled to preliminary and permanent injunctions restraining and enjoining CVD from infringing the claims of the '522 Patent.

41. On information and belief, CVD's infringement has been and continues to be willful.

COUNT II

Infringement of the '534 Patent

42. O2Cure incorporates by reference each and every allegation contained in Paragraphs 1 through 41 above, as though set forth herein in their entirety.

43. On information and belief, CVD has infringed and continues to directly infringe one or more claims of the '534 Patent, including exemplary claim 16, in violation of 35 U.S.C. § 271(a) by making, using, offering to sell, and selling in this judicial district and elsewhere, fluid reactor and ECMO devices that include CVD's c-VACNT™ RCEs.

44. Exemplary claim 16 of the '534 Patent recites:

> A method for interacting a fluid with a gas, the method comprising the steps of:
> providing a plurality of fluid flow channels that are surrounded by hydrophobic pillar-shaped structures with diameters between 1 and 100nm, each of the channels having an inflow end and an outflow end, wherein each of the channels is wide enough for a fluid to flow through, and wherein the pillar-shaped structures are spaced close enough to each other to retain the fluid within the channels when the fluid is flowing through the channels;
> passing fluid […] through the channels; and
> passing a gas through the spaces between the pillar-shaped structures outside the fluid flow channels,
> wherein the gas interacts with the fluid in the channels.

45. CVD practiced the claimed "method for interacting a fluid a gas" as described in Exhibit 3. CVD tested its RCEs in "ECMO prototype devices" with "water as the primary fluid" interacting with "both O_2 or air as the sweep-gas." Exhibit 3, p. 8.

46. CVD provided at least one c-VACNT RCE containing "a plurality of fluid flow channels that are surrounded by" c-VACNT carbon nanotubes, as illustrated in Figure 7 of Exhibit 3:

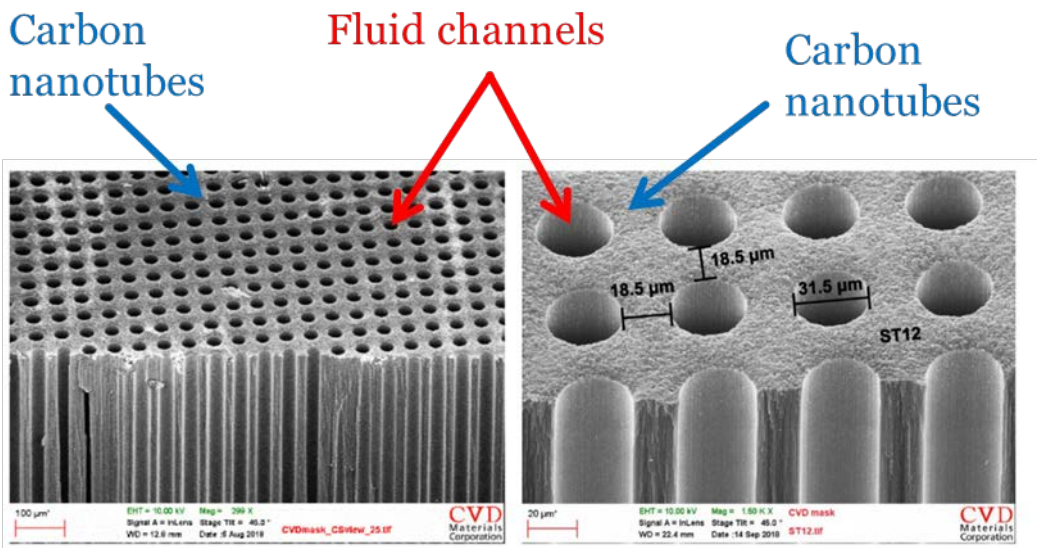


Figure 7: c-VACNT™-RCE with a non-tortuous flow path

Exhibit 3, Figure 7 (annotated).

47. Those c-VACNT carbon nanotubes are "hydrophobic pillar-shaped structures with diameters between 1 and 100nm" as recited in claim 16. The c-VACNT carbon nanotubes include vertical, pillar-shaped structures, as shown in Figure 2 of Exhibit 3:

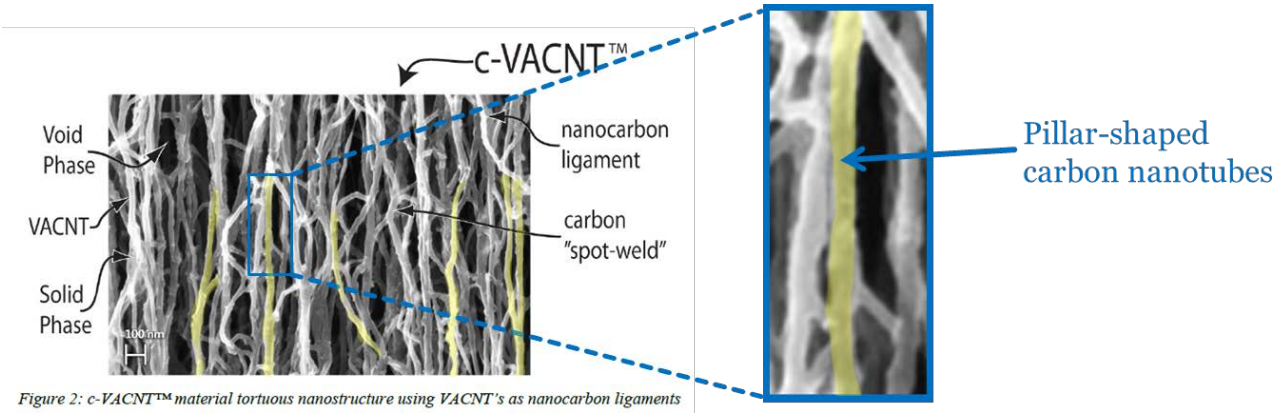


Figure 2: c-VACNT™ material tortuous nanostructure using VACNT's as nanocarbon ligaments

(Based on Exhibit 3, Figure 2 with annotation, highlighting, and magnification window added).

48. Further, CVD added "hydrophobic coating material" to the c-VACNT pillar-shaped carbon nanotubes to give them "superhydrophobic" properties. CVD explained that by implementing an appropriate "hydrophobic coating material selection and a correctly chosen

hydrophobic coating process," it transformed uncoated c-VACNT carbon nanotubes into "a material with superhydrophobic (contact angle ≥ 150º) properties." Exhibit 3, p. 3.

49. As shown in annotated Figure 2 from Exhibit 3 below, based on the 100 nm scale provided, the diameters of the pillar-shaped carbon nanotubes are greater than 1 nm and less than 100nm:

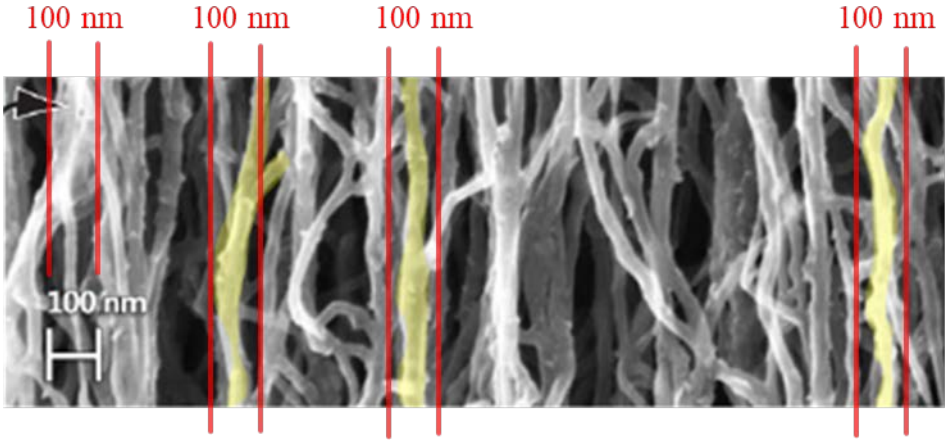


Exhibit 3, Figure 2 (annotated and highlighted).

50. Each of the fluid channels has an "inflow end and an outflow end" through which the primary input fluid "travels through." Exhibit 3, pp. 5-7.

51. As explained in paragraphs 31-34 of this Complaint, CVD demonstrated that "each of the channels is wide enough for a fluid to flow through" by passing water through the fluid channels in its ECMO prototype.

52. As explained in paragraph 32 of this Complaint, the pillar-shaped carbon nanotubes form the sidewalls of the fluid channels and are "spaced close enough to each other to retain the fluid within the channels when the fluid is flowing through the channels."

53. As explained in paragraphs 33-35 of this Complaint, CVD passed "fluid through the channels" when testing its ECMO prototype with water.

54. As explained in paragraphs 32-25 of this Complaint, Defendant passed "a gas through the spaces between the pillar-shaped structures outside the fluid flow channels" as claimed. In testing the ECMO prototype with water, Defendant passed oxygen and air through the spaces between the pillar-shaped carbon nanotubes to interact with the water in the fluid channels.

55. As explained in paragraphs 34 and 35 of this Complaint, CVD's testing demonstrated that "the gas interacts with the fluid in the channels."

56. On information and belief, CVD has and is actively, knowingly, and intentionally inducing infringement of the '534 Patent by research partners, customers, and other third parties in violation of 35 U.S.C. § 271(b). CVD has had knowledge of the '534 Patent at least as of the service of this Complaint, and has been aware that directing its customers or research partners to use the c-VACNT RCEs in an ECMO device infringes at least exemplary claim 16 of the '534 Patent.

57. On information and belief, CVD has induced, and is currently inducing, at least one university to directly infringe the '534 Patent by testing of ECMO devices incorporating CVD's c-VACNT RCEs with blood and oxygen or air. On information and belief, CVD is paying the university to conduct such testing.

58. CVD's infringement has been without permission, consent, authorization, or license from O2Cure.

59. By reason of CVD's infringing activity, O2Cure has suffered, and will continue to suffer, substantial damages in an amount to be determined at trial.

60. CVD's infringing acts complained of herein have damaged and will continue to damage O2Cure irreparably. O2Cure has no adequate remedy at law for these wrongs and

injuries, and is therefore entitled to preliminary and permanent injunctions restraining and enjoining CVD from infringing the claims of the ’534 Patent.

61. On information and belief, CVD’s infringement has been and continues to be willful.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff O2Cure respectfully requests judgment and relief against CVD as follows:

A. That CVD has directly infringed and is directly infringing the Asserted Patents, and that CVD has induced and is inducing infringement of the Asserted Patents;

B. That such infringement is willful;

C. That CVD and its subsidiaries, affiliates, officers, directors, agents, servants, employees, successors, and assigns, and all other persons and organizations in active concert or participation with them, be preliminarily and permanently enjoined from further acts of infringement of the Asserted Patents pursuant to 35 U.S.C. § 283;

D. That CVD be ordered to pay damages adequate to compensate O2Cure for CVD’s infringement of the Asserted Patents, together with prejudgment and post-judgement interest and costs pursuant to 35 U.S.C. § 284;

E. That this case be declared exceptional pursuant to 35 U.S.C. § 285 and that O2Cure be awarded its reasonable attorneys’ fees, litigation expenses, expert witness fees, and costs; and

F. Such other relief deemed appropriate by the Court.

DEMAND FOR JURY TRIAL

Plaintiff O2Cure demands a trial by jury on all issues so triable.

Dated this 15th day of November, 2019.

Respectfully submitted,

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